Feedback Stabilization at SPEAR3

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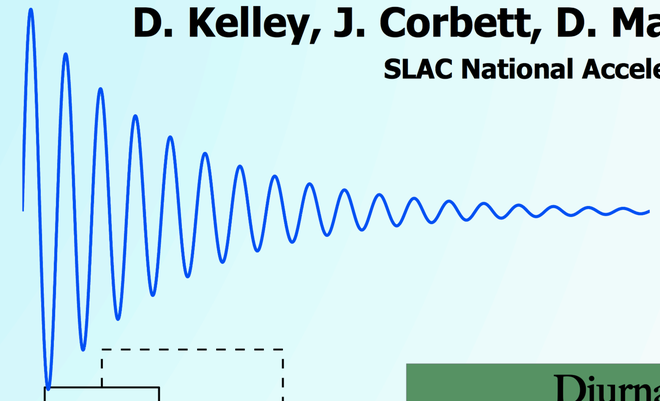
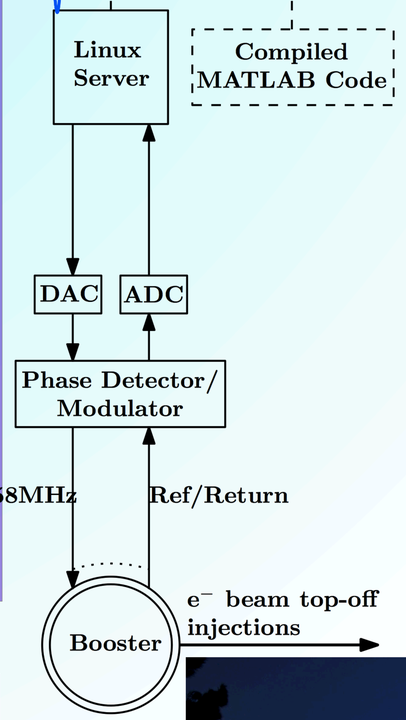
Abstract

The SPEAR3 synchrotron lightsource at SLAC relies on a sophisticated radio frequency (RF) timing system to maintain current – electrons – in the storage ring. One problem SPEAR3 operators have dealt with is the thermal expansion of one of the cables supporting this RF timing system. As the cable expands and contracts with the diurnal rise and fall of the sun, the phase of the RF in the cable shifts. This shifting phase affects the timing accuracy of electron injections into the storage ring.

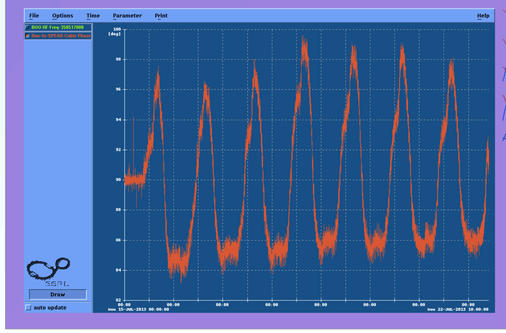
A common feedback control algorithm PID (Proportional Integral Derivative) has countless applications in engineering. PID feedback can solve this problem of diurnal phase shift nicely. In general, feedback control of a dynamic variable requires the completion of a feedback loop; the variable is fed as input to the controller, which in turn modifies the variable. These principles were used to write a software program that controls a phase modulation box to compensate for the thermal expansion of the RF timing cable. The software was written and compiled with MATLAB, and interfaces with the EPICS control system at SLAC to control the hardware. The system also provides diagnostic tools and software control of the phase in this part of the timing system.

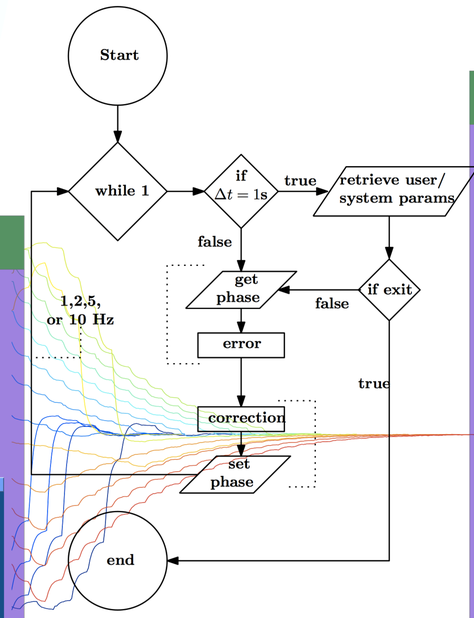


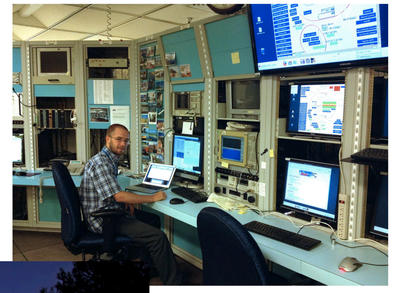


Diurnal Shift

- Caused by thermal expansion
- Phase of RF signal effected
- Injection rate effected
- Historically required manual compensation

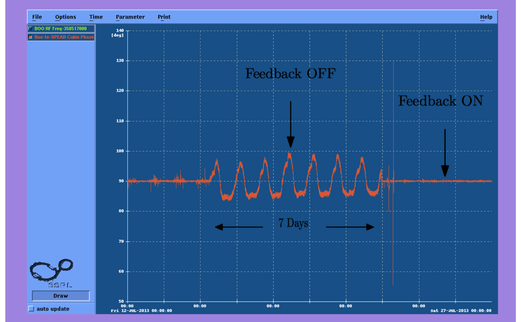






Feedback

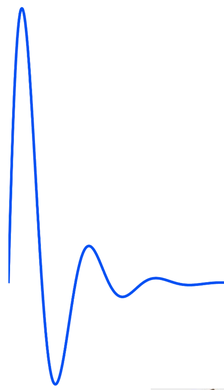
- Infinite "while loop" in MATLAB
- Uses EPICS (Experimental Physics and Industrial Control System)
- Channel Access protocol allows for communication with hardware
- Obsoletes manual phase control
- Diagnostics for phase anomalies
- GUI designed for operators
- Successful deployment



RF Timing

- 358.5 MHz
- 100m Cable
- From Control Room to Booster
- Controls injection

Very precise timing is required when injecting electrons into the synchrotron. The timing signal is delivered via RF.



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